PATENT APPLICATION
Docket No. 10007137-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of:	Gibson et al.	)
Serial No.:	09/865,940	)
Filed:	May 25, 2001	)
Art Unit	2655	)
For:	Data Storage Media Utilizing Directed Light Beam And Near-Field Optical Sources	)
Examiner:	Nabil Z. Hindi	)

BRIEF OF APPELLANT

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellants filed a timely Notice of Appeal from the action of the Examiner in finally rejecting all of the claims in this application dated November 30, 2004. This brief is being filed under the provisions of 37 C.F.R. § 41.37. The filing fee of $500.00, as set forth in 37 C.F.R. § 41.20(b)(2) for a large entity, plus the one month extension of time fee of $120.00 for a large entity, are submitted herewith.

CERTIFICATE OF MAILING

DATE OF DEPOSIT: June 17, 2005

I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being deposited with the United States Postal Service as first class mail, service under 37 C.F.R. § 1.8 with sufficient postage on the date indicated above and is addressed to: Mail Stop Appeal Brief - Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Vaughn W. North

REAL PARTY IN INTEREST

The real party in interest is Hewlett-Packard Company, by way of assignment from Gary A. Gibson and Alison Chaiken, who are the named inventors and are captioned in the present brief.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

STATUS OF CLAIMS

Claims 1-25 are pending, Claims 1-5, 8-17, and 19-25 stand finally rejected and are appealed in the present application, and Claims 6, 7, and 18 are objected to.

STATUS OF AMENDMENTS

No amendments to the claims have been made. In response to the Examiner's first action dated March 10, 2004, applicants submitted a Response dated June 10, 2004 along with a signed Declaration of Gary A. Gibson swearing behind cited U.S. Patent No. 6,473,388, and an unsigned copy of a similar Declaration of Alison Chaiken. A Notice of Non-Compliant Amendment dated September 7, 2004 was received in response to the June 10, 2004 Response from applicants pointing out that the Remarks did not begin on a separate sheet. Thereafter, applicants resubmitted the Response, then dated September 24, 2004. Copies of the Declarations of Gary A. Gibson and Alison Chaiken were not included with the resubmitted response. The Examiner issued his Final Rejection dated November 30, 2004. In his Final Rejection, the Examiner stated that the claims are

rejected for the same reasons set forth in the previous office action mailed March 10, 2004. The Examiner also stated that no Declaration had been received.

Applicants then filed a Response After Final along with a newly signed Declaration of Gary A. Gibson and a signed Declaration of Alison Chaiken. The claims were not amended. The Examiner issued an Advisory Action dated March 3, 2005 advising that the Response After Final does not place the application in condition for allowance, but did not mention Declarations. Further, none of the boxes 8, 9, or 10 of the Advisory Action were checked. Thus, the Examiner did not indicate whether or not the Declarations were entered or were refused entry. However, the Examiner listed in the Advisory Action Claims 1-5, 8-17, and 19-25 as rejected and Claims 6, 7, and 18 as objected to. The Examiner's objections were not indicated. It is assumed that the objection is that the claims depend from rejected claims. Because the claims now indicated as objected to were claims previously rejected under Patent No. 6,473,388 to which the Declarations were directed and such claims were not otherwise rejected, because there is no indication that the Declarations were refused entry, and because the Examiner indicated that the "proposed amendments" "will be entered", applicants conclude that the Declarations have been entered and Patent No. 6,473,388 has been withdrawn as a reference.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention, as defined by independent Claim 1, provides a data storage unit with a data storage layer 42, Fig. 3, having a plurality of data storage areas 45, Fig. 3, for storing and reading data thereon during read and write phases, respectively (Page 9, lines 7-9, Page 10, lines 21-27). A light beam emitter 43, Fig. 3, in close proximity to the

data storage layer 42, selectively directs a first light beam 46 to the data storage layer 42 to write data in certain data storage areas 45 during a write phase (Page 10, lines 28-31) and directs a second light beam 46 to the data storage layer 42 to read data in certain data storage areas 45 during a read phase (Page 11, lines 17-18). A medium disposed on the data storage areas 45 changes between a plurality of states in response to the first directed light beam 46 during the write phase (Page 9, lines 10-28, Page 11, lines 1-16) and generates electron-hole pairs in response to the second directed light beam 46 during the read phase (Page 9, lines 28-30, Page 11, lines 17-18). The plurality of states of the medium exhibit substantial differences in the activity of electron-hole pairs generated in response to the second directed light beam (Page 9, line 28-Page 10, line 3, Page 11, lines 17-21). A detection region 47 in communication with the data storage areas 45 determines the activity of the electron-hole pairs during the read phase, the activity of electron-hole pairs being related to the state of each storage area (Page 10, lines 4-7, Page 11, lines 18-25). A detector (the voltage source 48 and associated unnumbered resistor which generates detection signal 49) associated with the detection region 47 measures the activity of the electron-hole pairs to determine the data stored in the data storage area (Page 11, lines 25-27).

The present invention, as defined by independent Claim 15, provides a device for reading data stored in a data storage unit with a data storage layer 42, Fig. 3, having a plurality of data storage areas 45, Fig. 3, each having a medium disposed thereon susceptible to changing states in response to the application of energy to the medium (Page 10, lines 13-18). The device includes a light beam emitter 43, Fig. 3, in close proximity to the data storage layer 42 for selectively directing a light beam 46 to excite the medium in selected data storage areas 45 to generate electron-hole pairs (Page 9, lines

28-30, Page 11, lines 17-18). The activity of generated electron-hole pairs is related to the state of the medium in a data storage area 45 (Page 9, line 28-Page 10, line 3, Page 11, lines 17-21). A detection region 47 in communication with the data storage areas 45 detects the activity of the electron-hole pairs during the read phase, the activity of the electron-hole pairs being variable in response to excitation of the data storage areas by the light beam emitter 43 and the state of the data storage areas 45 (Page 10, lines 4-7, Page 11, lines 18-25). A detector (the voltage source 48 and associated unnumbered resistor which generates detection signal 49) measures the activity of electron-hole pairs in the detection region 47 to determine the data stored in the data storage areas 45 (Page 11, lines 25-27).

The present invention, as defined by independent Claim 20, is a method for writing and reading data in a data storage unit including a data storage layer 42, Fig. 3, having a plurality of data storage areas 45 with a medium disposed thereon that is susceptible to changing states in response to light beam energy for storing and reading data thereon during read and write phases, respectively (Page 6, lines 6-10). The method comprises the steps of selectively directing a first light beam 46 from a light beam emitter 43 in close proximity to the data storage layer 42 to the medium to write data in certain data storage areas 45 during the write phase by changing the state of the medium (Page 6, lines 10-13). The data is read by selectively directing a second light beam 46 from a light beam emitter 43 in close proximity to the data storage layer 42 to the medium in selected data storage areas 45 during the read phase to generate electron-hole pairs (Page 6, lines 13-16). The activity of the generated electron-hole pairs is related to the state of the medium and indicates the presence of data bits in the storage areas 45 (Page 6, lines 16-20). The activity of the generated electron-hole pairs is determined during the read phase

by measuring the amount of electron-hole pair activity in a detection region 47 in communication with the data storage areas 45 (Page 6, lines 17-20).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. The Examiner has rejected Claims 1-5, 8-17 and 19-25 under 35 USC 102(b) as anticipated by Gibson et al. Patent No. 5,557,596. Gibson et al. show a storage device similar to that shown in Figs. 3 and 5 of the present application wherein an electron beam rather than a light beam is used to write data and read data. The Examiner's rejection, from the Advisory Action dated March 3, 2005, is that although the application shows "light emitters", "a 'light beam' is merely made in part of electrons, thus an electron emitter is merely a light meeting the claimed invention."

2. The Examiner had rejected Claims 1-25 under 35 USC 102(e) as anticipated by Gibson Patent No. 6,473,388. Gibson shows a storage device similar to that shown in Fig. 4 of the present application, but again using an electron beam to read and write the data. However, Gibson indicates that "The energy beam source is not limited to electron emitters. . . . For example, a near-field optical source can generate a light beam that creates electron-hole carriers . . ." Applicants have submitted Declarations of the inventors of the current application swearing behind the Gibson reference. As indicated above, although the Examiner has not specifically indicated in his Advisory Action that the Declarations have been entered, the Declarations appear to have been entered and the Gibson reference withdrawn. Unless otherwise indicated by the Examiner, this ground of rejection is no longer a ground of rejection by the Examiner and thus no longer a ground of rejection to be reviewed on appeal.

ARGUMENT

Rejection under 35 USC 102 (b) as anticipated by Gibson et al. Patent No. 5,557,596

The Examiner has rejected Claims 1-5, 8-17 and 19-25 under 35 USC 102(b) as anticipated by Gibson et al. Patent No. 5,557,596. Gibson et al. show a storage device similar to that shown in Figs. 3 and 5 of the present application wherein an electron beam rather than a light beam is used to write data and read data. The Gibson et al. 596 patent was cited and distinguished in the present application. The Gibson et al. 596 patent focused on using electron emitters generating beams of electrons in a data storage system to impact and change the state of storage material, which would then be detected in a carrier flow in any of several different detection devices described therein. The Gibson et al. 596 patent did not disclose or teach the use of light beam emitters for such a data storage system.

Several limitations arise with the use of electron beams in the storage devices shown, including dielectric breakdown, field emission from undesirable locations, and the need for relatively large and expensive power supplies. As stated on page 3 of the present application:

> "It is possible to use low energy electrons in this technique to avoid problems with dielectric breakdown, field emission from undesirable locations, and the need for relatively large and expensive power supplies. However, low energy electrons have very short penetration depths, making this approach highly susceptible to the surface conditions of the medium. Moreover, only very thin layers may be present on the top of the storage media, making difficult the use of a protective layer or a conducting electrode on top of the storage layer. In addition, the stability and cyclability of a storage device using electron-readback may be limited by the mechanical and thermal properties of the free surface of the storage medium. Only very thin protective cladding layers can be used with a low-energy electron-beam addressing scheme, as these layers would prevent access by low energy electrons."

The present invention utilizes light beam emitters, rather than electron emitters, to overcome some of these limitations. For example, as stated on page 5 of the subject application:

> "The use of light for reading and writing, having much greater penetration depth than electron beams, enables the use of deeper storage layers, as well as protective layers over the storage layers. Optically-transparent electrodes may be placed on top of the storage layer."

Claims 1-25 of the present application are limited to the use of light beams and light beam emitters, a substantial difference from the disclosure in the Gibson et al. 596 patent, which is limited in its disclosure to the use of electron beams. The Examiner does not appear to dispute this indicated difference between the present application and the Gibson et al. reference. The Examiner's rejection, from the Advisory Action dated March 3, 2005, is that although the application shows "light emitters", "a 'light beam' is merely made in part of electrons, thus an electron emitter is merely a light meeting the claimed invention." Thus, the Examiner's position is that an electron beam is a light beam.

The American Heritage Dictionary of Science, 1986, defines an "electron beam" as "a stream of electrons moving in the same direction and with the same velocity." An "electron" is defined as "an elementary particle having a very small mass at rest (9.095×10^{-28} gram) and a unit charge of negative electricity equal to 1.60219×10^{-19} coulombs." The same Dictionary defines "light" as "a form of radiant energy consisting of electromagnetic waves that travel freely through space in a vacuum at a speed of 299,792 kilometers per second. The wavelength of light waves is measured in nanometers; the frequency of light waves is measured in hertz." An electron beam is a stream of particles while a light beam is a beam of electromagnetic waves. These are clearly different. An

electron beam is not a light beam and a light beam is not an electron beam. The two cannot be equated. The difference in results with regard to penetration depth, i.e., that light beams have a "much greater penetration depth than electron beams" indicated in the present application as an advantage with using light beams rather than electron beams in the present invention supports that light beams are different from electron beams. If the two were the same, there should be no differences in using one over the other.

It is submitted that a light beam is not merely in part an electron beam as argued by the Examiner and that light beams and electron beams are fundamentally different. Accordingly, it is submitted that Gibson et al's use of electron beams does not anticipate applicants' use of light beams and therefore does not anticipate Claims 1-5, 8-17, 19-25 of the present application.

Rejection under 35 USC 102 (b) as anticipated by Gibson Patent No. 5,557,596

The Examiner had rejected Claims 1-25 under 35 USC 102(e) as anticipated by Gibson Patent No. 6,473,388. Gibson shows a storage device similar to that shown in Fig. 4 of the present application, but again using an electron beam to read and write the data. However, Gibson indicates that "The energy beam source is not limited to electron emitters. . . . For example, a near-field optical source can generate a light beam that creates electron-hole carriers . . ."

Applicants have submitted Declarations of both current inventors, Gary A. Gibson and Alison Chaiken, under Rule 131, both stating that the invention as described and claimed in the subject patent application was conceived and reduced to practice prior to August 31, 2000, the filing date of the Gibson 388 patent, together with accompanying exhibits. Although the Examiner has not specifically indicated in his Advisory Action that the Declarations have been entered, the Examiner listed in the Advisory Action

Claims 1-5, 8-17, and 19-25 as rejected and Claims 6, 7, and 18 as objected to. Because the claims now indicated as objected to were the claims previously rejected under Patent No. 6,473,388 to which the Declarations were directed and such claims were not otherwise rejected, because there is no indication that the Declarations were refused entry, and because the Examiner indicated that the "proposed amendments" "will be entered" for purposes of appeal, it appears that the Declarations have been entered and Patent No. 6,473,388 has been withdrawn as a reference. Thus, this ground of rejection appears to have been withdrawn by the Examiner.

CONCLUSION

In view of the foregoing, Appellants respectfully request the Board to overturn the Examiner's rejections of the appealed claims 1-25.

Dated this 17th day of June, 2005.

Respectfully submitted,

Vaughn W. North
Attorney for Appellants
Registration No. 27,930

THORPE NORTH & WESTERN, LLP
P.O. Box 1219
Sandy, Utah 84091-1219
Telephone: (801) 566-6633

CLAIMS APPENDIX: CLAIMS ON APPEAL

1. A data storage unit, comprising:

a data storage layer having a plurality of data storage areas for storing and reading data thereon during read and write phases, respectively;

an array of directed light beam emitters in close proximity to the data storage layer for selectively directing a first light beam to the data storage layer to write data in certain data storage areas during the write phase and for selectively directing a second light beam to the data storage layer to read data in certain data storage areas during a read phase;

a medium disposed on the data storage areas that changes between a plurality of states in response to the first directed light beam during the write phase, and that generates electron-hole pairs in response to the second directed light beam during the read phase, the plurality of states exhibiting substantial differences in the activity of electron-hole carrier pairs generated in response to the second directed light beam;

a detection region in communication with the data storage areas for determining the activity of the electron-hole pairs during the read phase, the activity of electron-hole pairs being relative to the state of each storage areas; and

a detector associated with the detection region for measuring the activity of the electron-hole carrier pairs to determine the data stored in the data storage areas.

2. The data storage unit as recited in claim 1, wherein the array of light beam emitters comprises near-field light emitters for selectively directing an evanescent field from the light emitters onto the data storage layer to write data into the data storage areas and to read said data.

3. The data storage unit as recited in claim 1, wherein the detection region is the junction of a semiconductor diode and the activity of the electron-hole carrier pairs

comprises the amount of electron-hole carrier pairs that flow across the junction of a semiconductor diode.

4. The data storage unit as recited in claim 3, wherein the detector for measuring electron-hole carrier pair activity is a voltage detector for measuring the photovoltage developed across the junction.

5. The data storage unit as recited in claim 3, wherein the detector for measuring the amount of electrical carrier flow is a meter for measuring the flow of carriers across the semiconductor diode junction.

6. The data storage unit as recited in claim 1, wherein the region for detecting the electron-hole carrier pair activity comprises a photoconductivity region having a photoconductive material and two spaced apart electrodes with a potential across the two electrodes to direct the carrier flow between the electrodes in the photoconductive material.

7. The data storage unit as recited in claim 6, wherein the detector for measuring the amount of electrical carrier flow is a meter for measuring the flow of carriers between the electrodes in the photoconductive material.

8. The data storage unit as recited in claim 1, wherein the medium is a photo-luminescent material responsive to the second light beam for generating photon emissions in response to the recombination of the electron-hole carrier pairs generated during the read phase.

9. The data storage unit as recited in claim 8, wherein the detector region is a photodiode for generating current in response to the photon emissions.

10. The data storage unit as recited in claim 1, and further comprising a layer superimposed over the storage layer to protect the storage layer.

11. The data storage unit as recited in claim 1, wherein the medium comprises a material susceptible to changing states in response to the first directed light beam.

12. The data storage unit as recited in claim 1, and further comprising a secondary layer adjacent to the storage layer to enhance the thermal properties of the data storage unit.

13. The data storage unit as recited in claim 1, and further comprising a secondary layer adjacent to the storage layer to enhance the optical properties of the data storage unit.

14. The data storage unit as recited in claim 1, and further comprising a secondary energy source for biasing the storage areas to facilitate data storage or reading.

15. A device for reading data stored in a data storage unit, comprising:

a data storage layer having a plurality of data storage areas including a medium disposed thereon susceptible to changing states in response to the application of energy to the medium;

an array of directed light beam emitters in close proximity to the data storage layer for selectively reading the data stored in the data storage areas by directing light beams to excite the medium in the data storage areas and generate electron-hole pairs, the activity of generated electron-pairs being relative to the state of the medium in each data storage area;

a detection region in communication with the data storage areas for detecting the activity of the electron-hole pairs during the read phase, the amount of activity being variable in response to excitation of the data storage areas by the light beam emitters and the state of the data storage areas; and

a detector for measuring the amount of electron-hole carrier pair activity in the detection region to determine the data stored in the data storage areas.

16. The device for reading data as recited in claim 15, wherein the array of light beam emitters comprises near-field light emitters spaced less than a light wavelength from the data storage layer for selectively directing an evanescent field from the light emitters onto the data storage layer to write data into the data storage areas and to read said data.

17. The device for reading data as recited in claim 15, wherein the region for detection of electron-hole pair activity comprises a semiconductor diode junction having a potential across the junction for directing the carrier flow across the junction and wherein the electron-hole pair activity comprises the amount of electron-hole pairs flowing across the junction.

18. The device for reading data as recited in claim 15, wherein the region for controlling the detection of the electron-hole carrier activity comprises a photoconductivity region having a photoconductive material and two electrodes with a potential across the two electrodes to direct the carrier flow between an emitter electrode and a receptor electrode in the photoconductive material and wherein the electron-hole carrier activity is the amount of electron-hole carriers that reach the receptor electrode.

19. The device for reading data as recited in claim 15, wherein the medium is a photo-luminescent material responsive to the directed light beam for generating photon emissions in response to the recombination of the electron-hole carrier pairs generated during the read phase.

20. A method for writing and reading data in a data storage unit including a data storage layer having a plurality of data storage areas with a medium disposed thereon that is susceptible to changing states in response to light beam energy for storing and reading data thereon during read and write phases, respectively, comprising:

selectively directing a first light beam to the medium to write data in certain data storage areas during the write phase by changing states of the medium using light beam emitters in close proximity to the data storage layer;

selectively directing a second light beam to the medium on the data storage areas to read data in certain data storage areas during the read phase by generating electron-hole pairs, the activity of the electron-hole pairs being relative to the state of the medium;

determining the activity of the electron-hole pairs during the read phase, the activity being in a detection region in communication with the data storage areas, the activity of electron-hole pairs being dependent on the state of each of the data storage areas; and

measuring the amount of electron-hole carrier pair activity in the detection region to detect the presence of data bits in the storage areas.

21. The method for storing and reading data recited in claim 20 wherein the step of selectively directing first and second light beams comprises:

arranging an array of near-field light emitters spaced less than a light wavelength from the data storage layer;

generating from the near-field light emitters a plurality of evanescent light fields in contact with the data storage layer to write the data on the medium in the data storage areas during the write phase and to read the data from the data storage areas during the read phase.

22. The method for storing and reading data recited in claim 20 wherein the electron-hole carrier pair activity is generated by carriers generated in the data storage layer in response to light from the light beams.

23. The method of storing and reading data recited in claim 20 wherein the electron-hole carrier pair activity is generated by photons generated in the data storage layer in response to light from the light beams.

24. The method of storing and reading data recited in claim 20 wherein during the read phase, the light beams are directed toward the storage area in a constant flux mode.

25. The method of storing and reading data recited in claim 20 wherein the light beams are directed toward the storage area in a modulated flux mode.

EVIDENCE APPENDIX: DECLARATIONS

Declaration of Gary A. Gibson and Declaration of Alison Chaiken appear to have been entered by the Advisory Action dated March 3, 2005. The rejection to which these Declarations were directed appears to have been withdrawn.

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PATENT & TRADEMARK OFFICE

PATENT APPLICATION
ATTORNEY DOCKET NO. 10007137-1

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 2655 EXAMINER: Nabil Z. Hindi APPLICANT: Gibson et al. SERIAL NO.: 09/865,940 FILED: May 25, 2001 CONFRM. NO.: 6644 FOR: DATA STORAGE MEDIA UTILIZING DIRECTED LIGHT BEAM AND NEAR-FIELD OPTICAL SOURCES	**RESPONSE/AMENDMENT** **CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: January 31, 2005 I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being deposited with the United States Postal Service with sufficient postage as first class mail on the date indicated above and is addressed to: Mail Stop Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. Vaughn W. North **Vaughn W. North**

DECLARATION OF ALISON CHAIKEN
UNDER 37 C.F.R. § 1.131

Commissioner for Patents
P.O. Box 1450
Arlington, VA 22313-1450

I, Alison Chaiken, declare as follows:

1. I am a named co-inventor in the above-captioned application and of the subject matter described and claimed therein.

2. It is my understanding that the claims in the above-recited patent application have been rejected in view of U.S. Patent No. 6,473,388 filed August 31, 2000 and issued to Gary A. Gibson, on October 29, 2002 (hereinafter the Gibson 388 Patent).

3. The invention as described and claimed in the above-reference patent application, Serial No. 09/865,940, filed May 25, 2001, entitled: "Data Storage Media Utilizing Directed Light Beam and Near-Field Optical Sources," ("Present Application") was conceived and reduced to practice by the inventors named therein prior to August 31, 2000.

4. Exhibit 1, attached hereto and dated June 27, 2000, is a set of slides used in a presentation that I gave that contains information about a reduction to practice of the invention in the Present Application. Slide 13 in Exhibit 1 shows some bits recorded in a phase-change material (In2Se3) using a laser light beam. The image was created in connection with the photoconductive readback structure that is one of the embodiments shown in the Present Application.

5. The presentation slides shown in Exhibit 1 are evidence of conception and reduction to practice of the invention in the Present Application prior to August 31, 2000, particularly with respect to the photoconductive readback embodiment shown therein.

6. Exhibit 2, attached hereto and dated August 30, 2000, is a copy of an invention disclosure that I and the other inventor in the Present Application, Gary A. Gibson, prepared and submitted to our employer, Hewlett Packard.

7. The document in Exhibit 2 is further evidence of conception and reduction to practice of the invention in the Present Application prior to August 31, 2000.

8. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States

Code, and that such willful, false statement may jeopardize the validity of the application or any patent issuing thereon.

Declared this 21st day of December, 2004.

Alison Chaiken

Exhibit 1 to Declaration of Alison Chaiken

Media Writing Experiments and Electrical Characterization

Alison Chaiken
Advanced Storage Department
June 27, 2000

- Electrical experiments: good transport properties in In_2Se_3
- Writing experiments: problems, success?
- Looking ahead to cyclability challenge

Purpose of Transport Experiments

- Track media film quality
- Select devices for more sophisticated measurements
- Provide parameters for device modeling
- 3 types of experiments:
  - Hall to measure carrier density, mobility
  - AC photoconductivity to measure frequency response
  - DC photocurrent to measure device performance.

invent

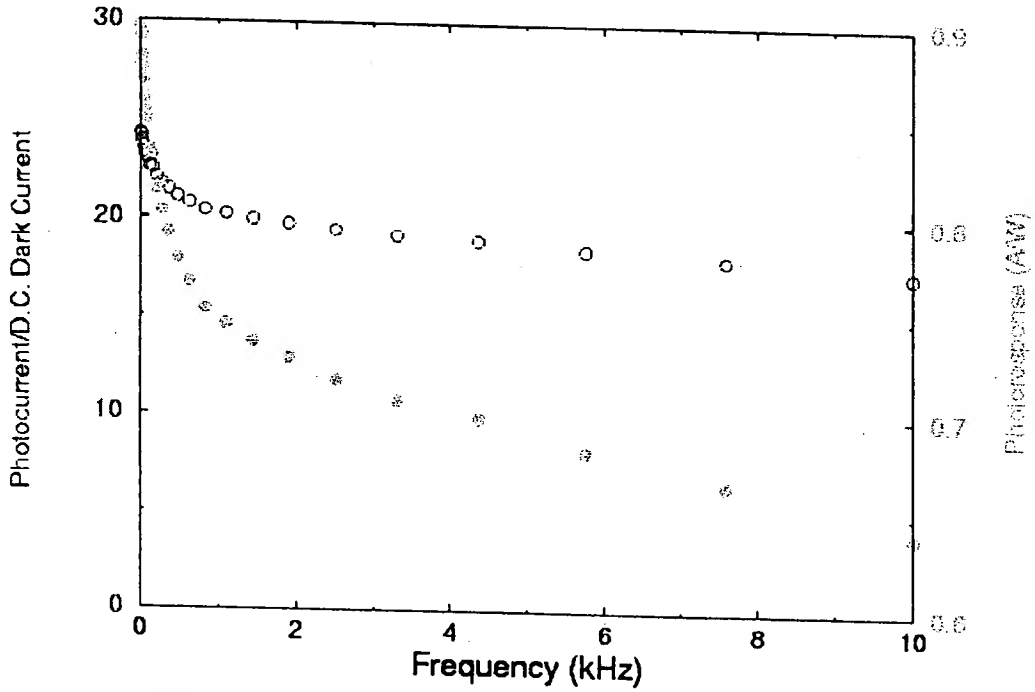
First Successful Hall Measurements on In_2Se_3

- Mobilities in the range 10 to 40 $cm^2/V\text{-}s$.
- Carrier densities 10^{12} to 10^{14} cm^{-3}, always n-type.
- Resistivities in the range of 10^3 to 10^5 ohm-cm:
  - may be too resistive for diodes;
  - good range for cathodoconductivity devices;
  - doping may lower resistivity (Te addition experiments).
- Correlation with deposition parameters is weak.

invent

Large Photoeffect in In_2Se_3

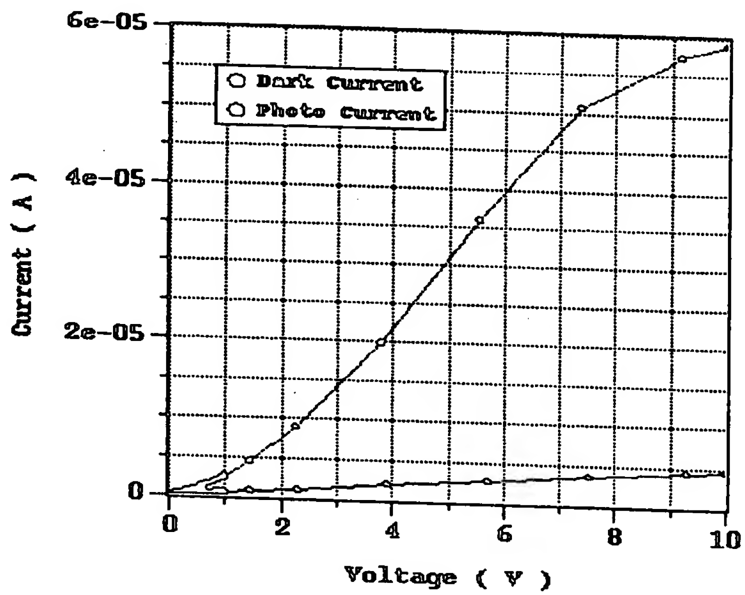
In_2Se_3 cathodoconductivity device



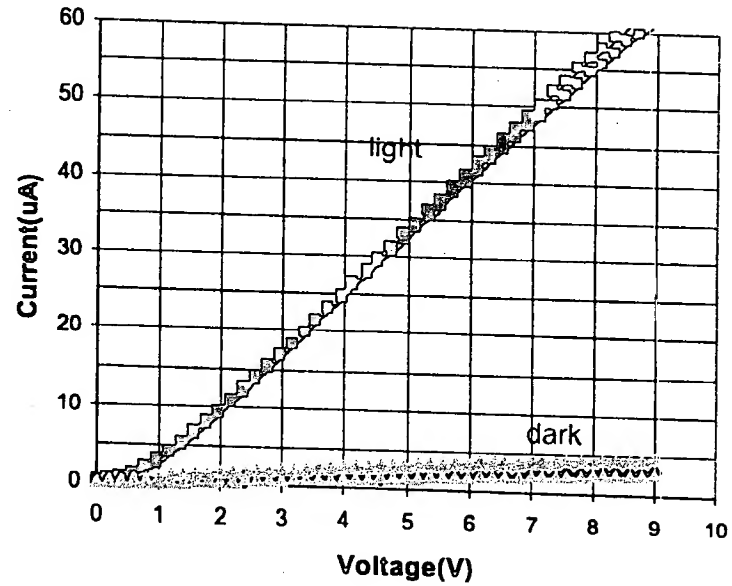
- Frequency dependence and magnitude indicate electronic origin.
- Predict large cathodoconductivity response.
- U. Nantes reports larger photoconductivity in Te-doped In_2Se_3 than in undoped In_2Se_3.

Modeling will help predict device performance

Model



Experiment

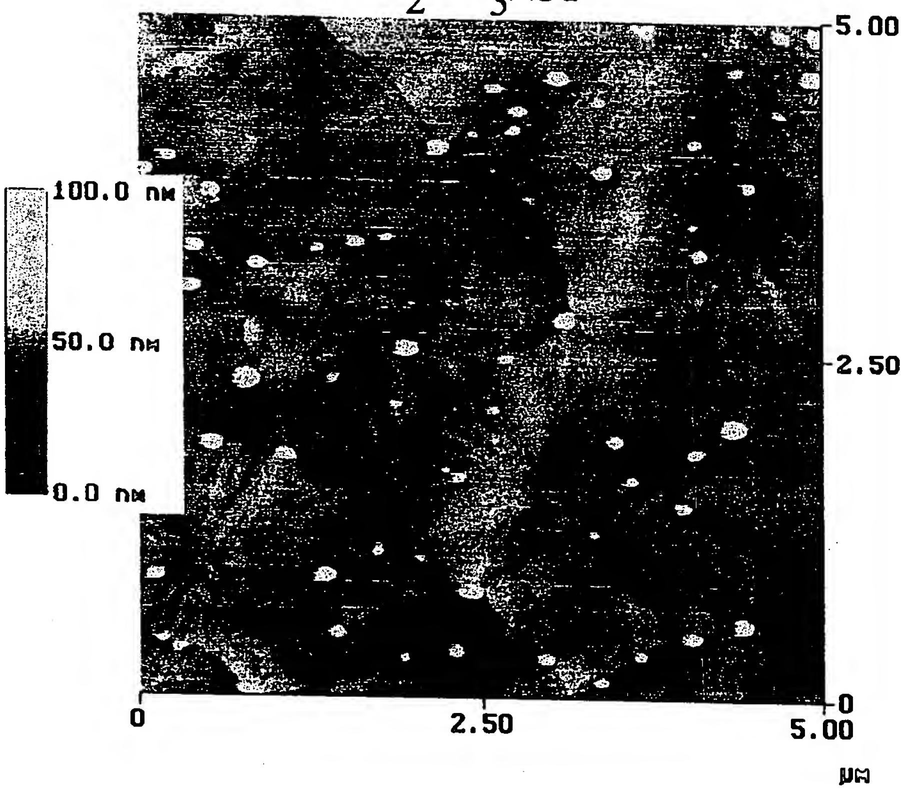


Courtesy Bao Yeh, ITP

invent

Grain size and transport properties

In_2Se_3/Si



- Hall devices are on SiO_2.
- Films have <= 100 nm grain size.
- Films on Si can have >=1µm grain size.
- Media films on diodes have better properties?

Enlarge grain size by annealing?

- AFM shows post-annealing films does not enlarge grain size;
  - needs quantitative x-ray study.
- Hall devices consistently more resistive after annealing in inert atmosphere, even capped films.
  - Films become more intrinsic?
  - Se loss at grain boundaries?
  - Oxidation at grain boundaries?

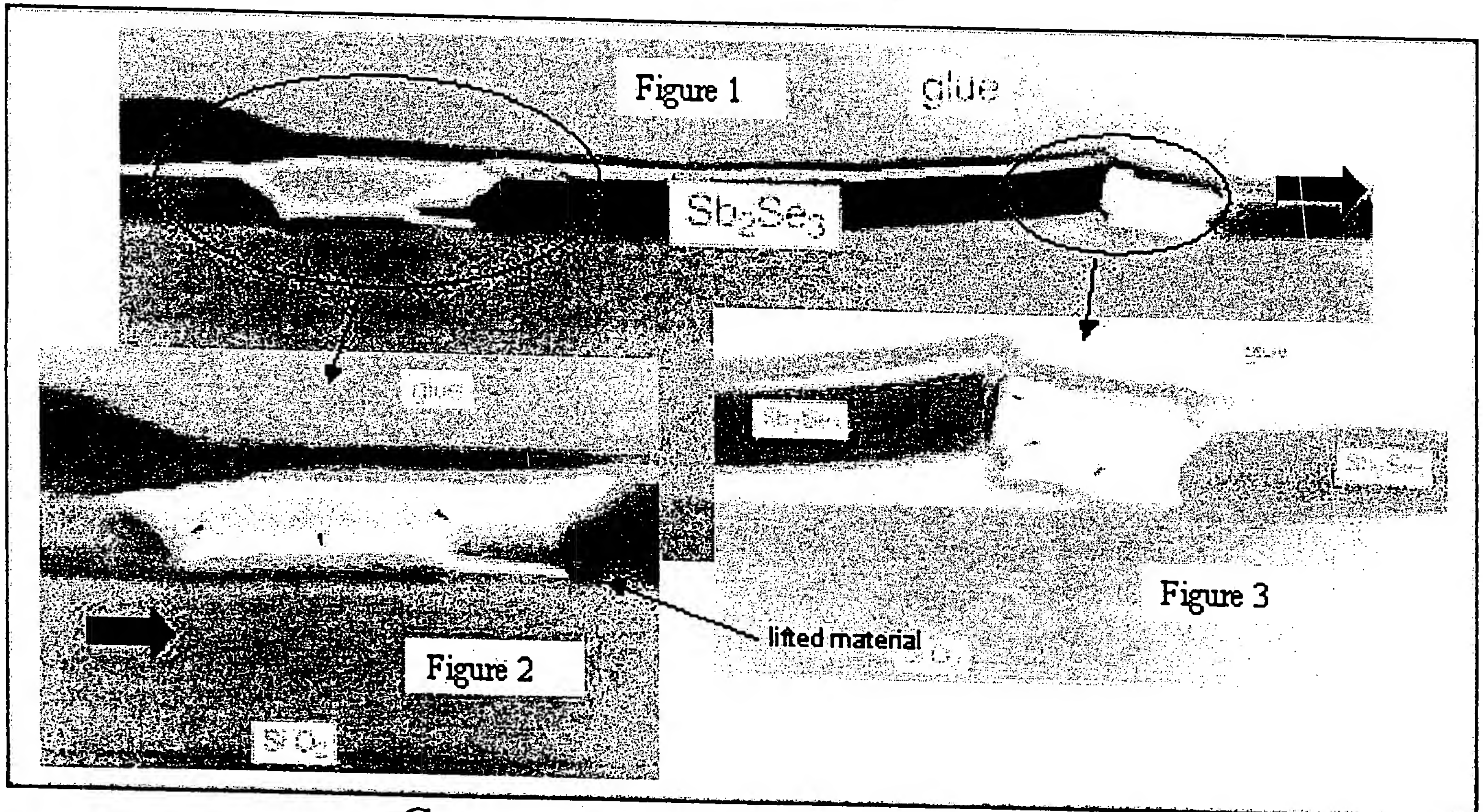
Grain size and transport properties

- Film electrical properties may be dominated by space-charge regions at grain boundaries.
- Grain boundary engineering an essential part of making devices work.
- New experiments:
  - Se cap layer to discourage composition changes;
  - hydrogen plasma annealing to passivate dangling bonds.

Writing Amorphous Marks on In_2Se_3 Media

- In some sense, a trivial task.
- However, problems may arise:
  - delamination of film from substrate or cracking;
  - decomposition or oxidation of In_2Se_3;
  - diffusion of excess Se;
  - sublimation at a temperature below melting.
- Reliably identifying the amorphous phase is another problem.

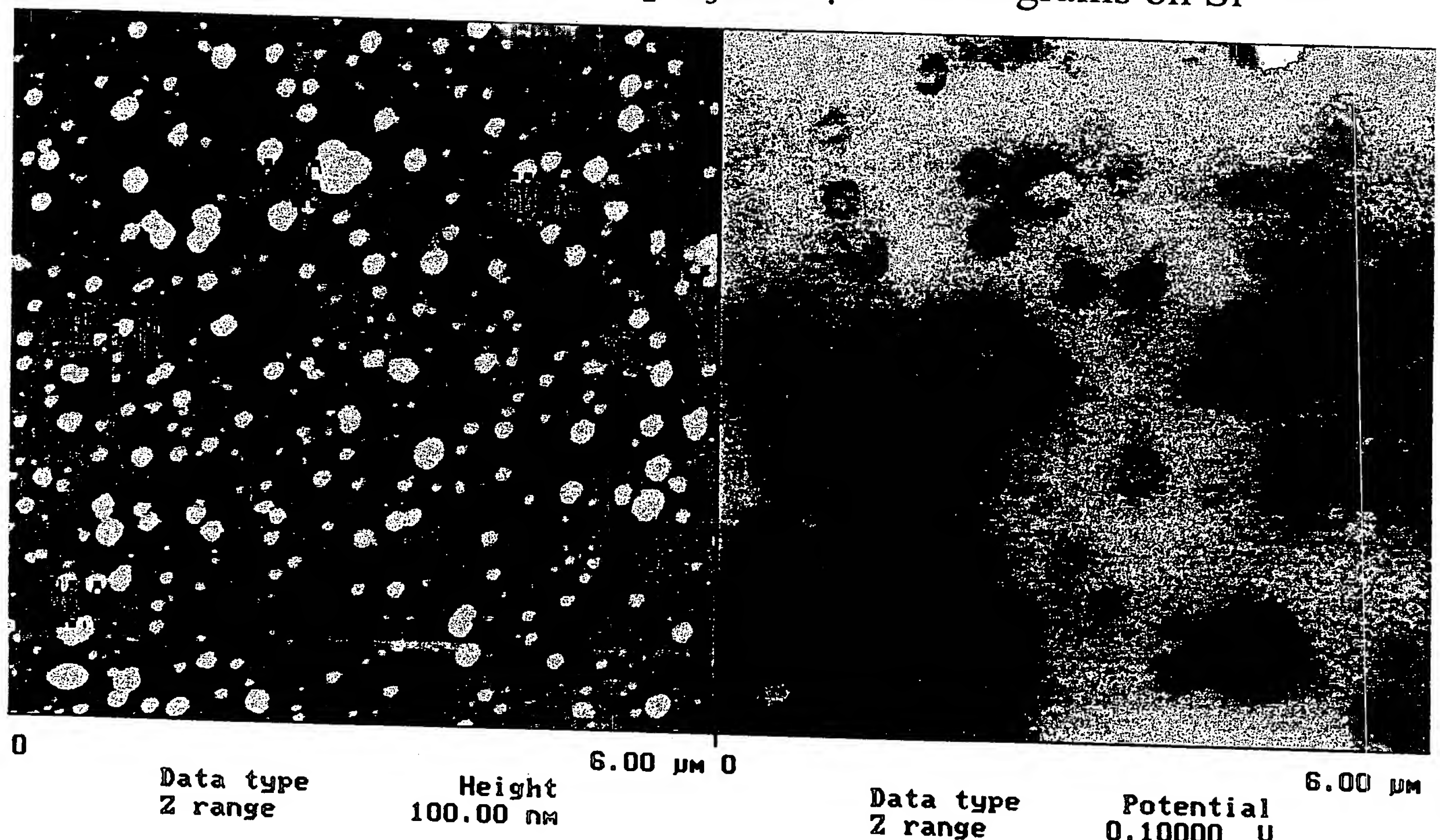
Writing Amorphous Spots on Sb2Se3 Successful



Courtesy of Chris Nauka and LBNL

Marking Films -- or Destroying Them?

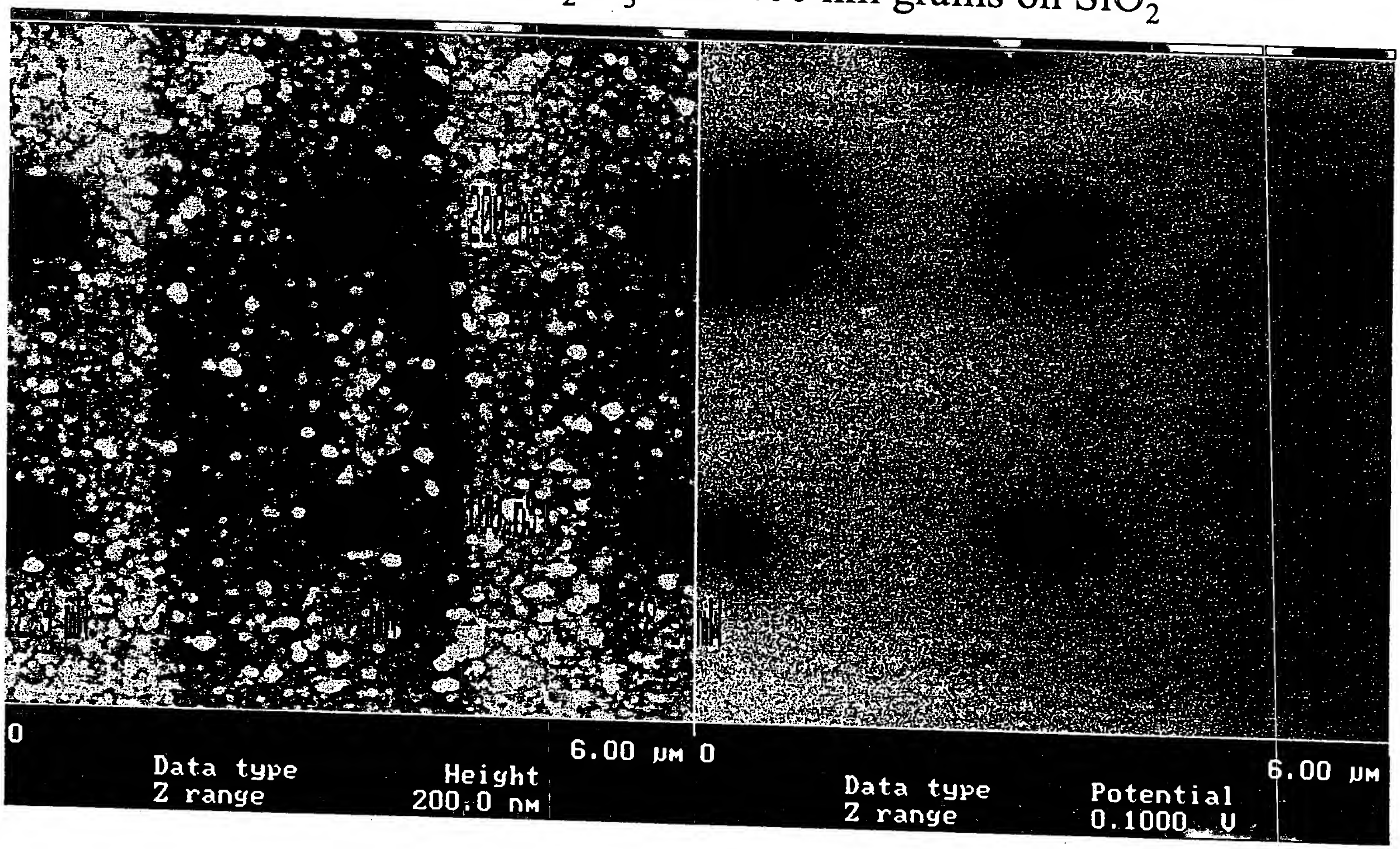
170 nm thick In_2Se_3 with μm-scale grains on Si



TEM so far inconclusive.

Small-grained films survive marking better

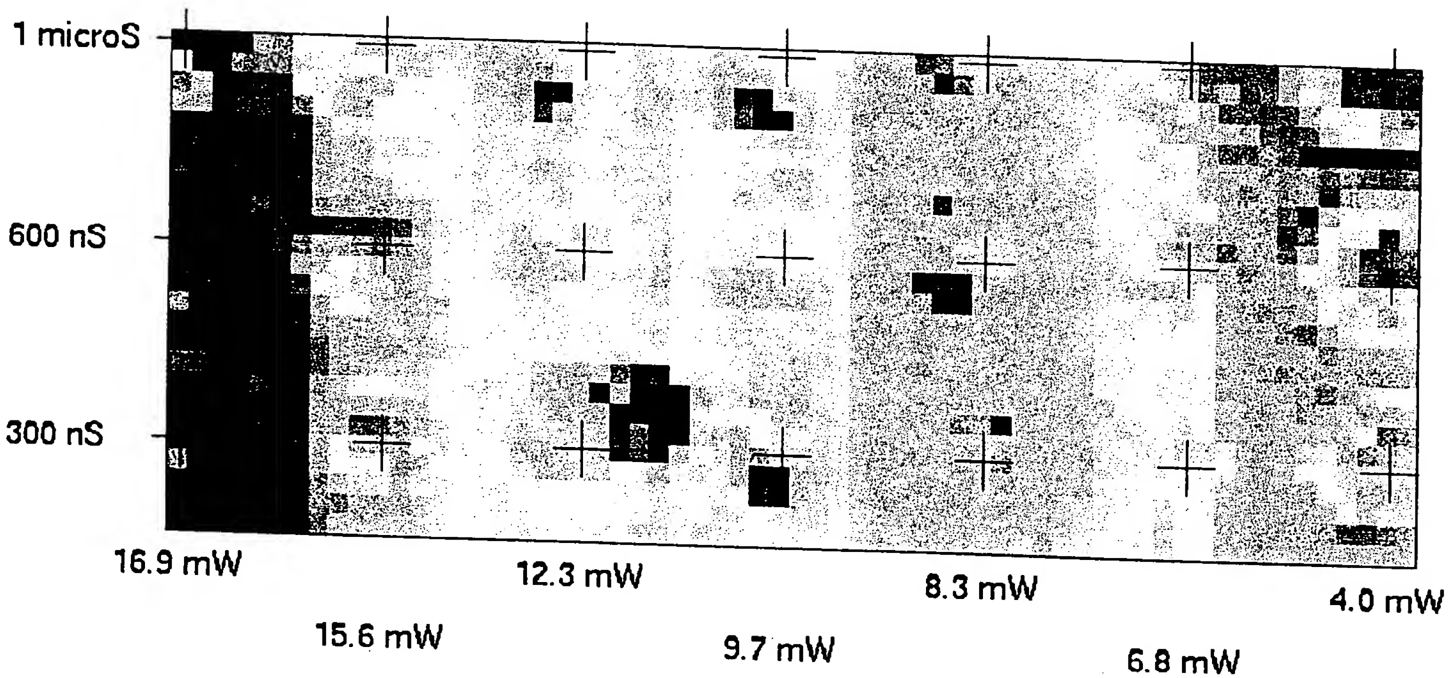
400 nm thick In_2Se_3 with 100 nm grains on SiO_2

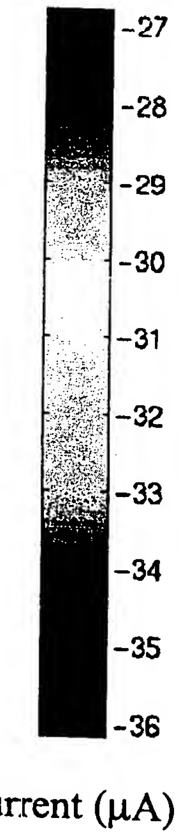


Thanks to G. Burward for improved sample fixturing.

Lasers Marks are Visible in Photocurrent Image

18x11 μm scan, -8V bias



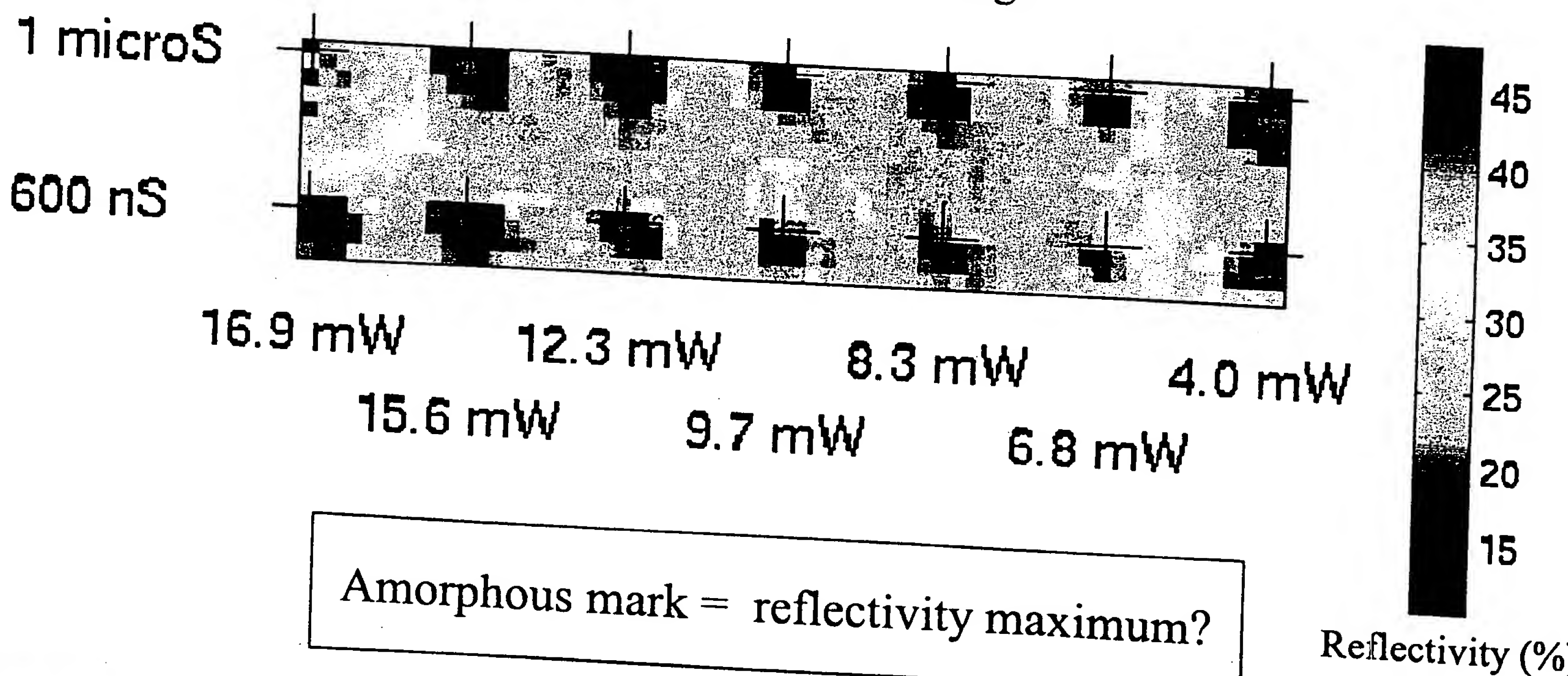


Best contrast is for marks on top of a contact . . .
Schottky diode?

Optical system built by Henryk Birecki.

Plenty of Questions Remain

18x4 μm Reflectivity Image

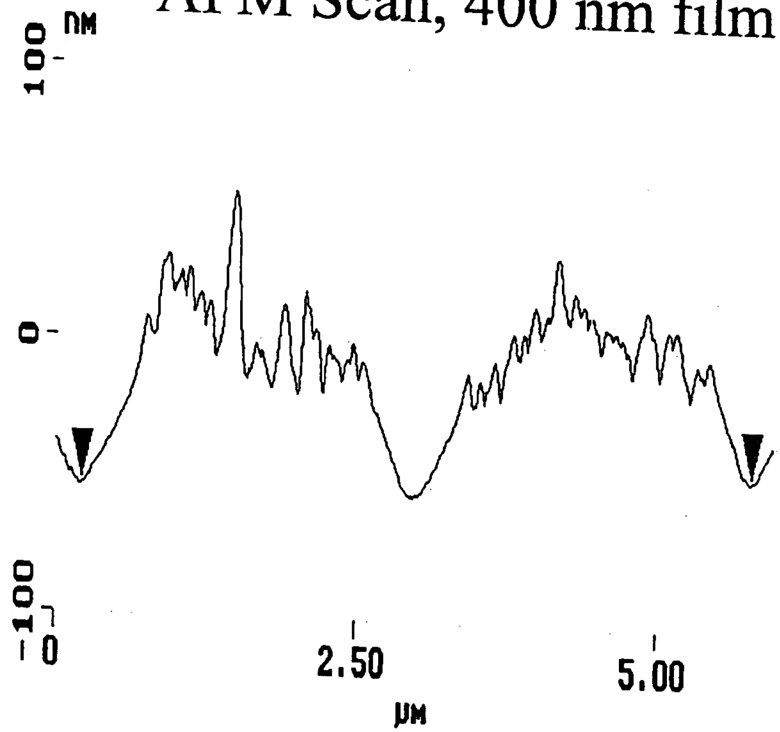


Amorphous mark = reflectivity maximum?

Plenty of Questions Remain

- Marks are noticeably smoother than background.
- In In_2Se_3, laser marks are always depressions.
- Absorption length of 488 nm light about 40 nm, similar to depth of depressions.

AFM Scan, 400 nm film



Future Work

- Correlate grain size and film texture to transport properties. (Y. Matsushita, SEED)
- Work with ITP to determine whether writing causes compositional changes.
- Work with Gary Ashton and Mauricio Huerta (MSB) to improve laser tester.
- Begin overwrite studies.
- Write amorphous marks on diodes.

Conclusions

- AFM, optical studies suggest amorphous spot writing has been achieved.
- Successful readback of laser marks on cathodoconductivity device.
- Transport properties of In_2Se_3 films are encouraging, possibly good enough.
- Cyclability remains an open question.

Exhibit 2 to Declaration of Alison Chaiken

HEWLETT PACKARD **INVENTION DIS OSURE** 9/12/00

PDNO 10007137 DATE RCVD

ATTORNEY THD

Instructions: The information contained in this document is ***COMPANY CONFIDENTIAL*** *and may not be disclosed to others without prior authorization. Submit this disclosure to the HP Legal Department as soon as possible. No patent protection is possible until a patent application is authorized, prepared, and submitted to the Government.*

Descriptive Title of Invention:
Data Storage Medium Utilizing Near-Field Optical Source

Name of Project:
Atomic Resolution Storage

Product Name or Number:

Was a description of the invention published, or are you planning to publish? If so, the date(s) and publication(s):
No.

Was a product including the invention announced, offered for sale, sold, or is such activity proposed? If so, the date(s) and location(s):
No.

Was the invention disclosed to anyone outside of HP, or will such disclosure occur? If so, the date(s) and name(s):
No.

If any of the above situations will occur within 3 months, call your IP attorney or the Legal Department now at 1-898-4919 or 970-898-4919.

Was the invention described in a lab book or other record? If so, please identify (lab book #, etc.)
Yes. Lab book #1814.

Was the invention built or tested? If so, the date:
No.

Was this invention made under a government contract? If so, the agency and contract number:
No.

Description of Invention: *Please preserve all records of the invention and attach additional pages for the following. Each additional page should be signed and dated by the inventor(s) and witness(es).*

A. Prior solutions and their disadvantages (if available, attach copies of product literature, technical articles, patents, etc.).
B. Problems solved by the invention.
C. Advantages of the invention over what has been done before.
D. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.)

Signature of Inventor(s): Pursuant to my (our) employment agreement, I (we) submit this disclosure on this date: [August 30, 2000].

Employee No.	Name	Signature	Telnet	Mailstop	Entity Acronym
268872	Gary Gibson	Gary Gibson	857-2125	2U-20	ISTL-ASD
498322	Alison Chaiken	Alison Chaiken	236-2231	2U-20	ISTL-ASD

(If more than four inventors, include additional information on another copy of this form and attach to this document)

Signature of Witness(es): *(Please try to obtain the signature of the person(s) to whom invention was first disclosed.)*

The invention was first explained to, and understood by, me (us) on this date: [APR. 14, 1995]

Full Name	Signature	Date of Signature
CHUNG CHING YANG	C C Yang	8/30/2000
Full Name	Signature	Date of Signature

Inventor & Home Address Information: *(If more than four inventors, include addl. information on a copy of this form & attach to this document)*

Inventor's Full Name
Gary Alfred Gibson

Street
119 Seale Avenue

City	State	Zip
Palo Alto	CA	94301

Do you have a Residential P.O. Address? P.O. BOX | City | State | Zip

Greeted as *(nickname, middle name, etc.)*	Citizenship
Gary	U.S.A.

Inventor's Full Name
Alison Chaiken

Street
On file

City | State | Zip

Do you have a Residential P.O. Address? P.O. BOX | City | State | Zip

Greeted as *(nickname, middle name, etc.)*	Citizenship
Alison	U.S.A.

Inventor's Full Name

Street

City | State | Zip

Do you have a Residential P.O. Address? P.O. BOX | City | State | Zip

Greeted as *(nickname, middle name, etc.)* | Citizenship

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A. Prior solutions and their disadvantages (if available, attach copies of product literature, technical articles, patents, etc.).

In conventional rewriteable optical recording devices such as CD-RW and DVD-RW drives, bits are written by using lasers to reversibly change the optical reflectivity of a storage medium. The diffraction-limited spot size of the lasers sets a lower bound to the size of the bits that can be written. Currently, a number of groups are working to increase the areal storage density of optical recording devices by using near-field light sources. These near-field sources use evanescent light emitted through a small aperture to circumvent the diffraction limit. In a typical embodiment, light from a laser is emitted through an aperture (that has a diameter less than the wavelength of the light) at one end of the laser cavity. Alternatively, the light from a laser is coupled into a fiber optic cable. The end of the cable furthest from the laser tapers down to a small diameter and is coated with a metal. This coated, tapered fiber forms a waveguide for the laser light. The tapered end of the fiber contains a small hole (diameter< wavelength of the light) that constitutes a near-field light source. In these approaches, some of the near-field light that is incident on the storage medium is reflected back into the laser cavity through the small aperture in the laser or the fiber-optic cable. This reflected light causes a change in the output power of the laser that can be monitored to detect changes in reflectivity and, thereby, the presence of bits. A disadvantage to this bit detection technique is the tiny amount of light that is reflected back into the laser cavity and the correspondingly small changes to the output power of the laser. To read very small bits it is desirable to have a technique capable of producing larger signals (and a larger ratio of signal to noise). The present invention provides this technique.

It has also been proposed (patent # 5,557,596) that an electron beam can be used to read and write data on the surface of a diode. It is desirable to use low energy electrons in this technique so as to avoid problems with dielectric breakdown, field-emission from undesirable locations, and the need for relatively large and expensive power supplies. However, low energy electrons have very short penetration depths. Thus, if low energy electrons are used, this technique is highly susceptible to the condition of the surface of the storage medium. In many cases this has an adverse effect on the functioning of this technique. The present invention is capable of circumventing this problem.

The necessity of getting the low-energy electrons into the storage layer also limits device designs, in that only very thin la yers may be present on top of the storage media. Thus, an optically transparent conducting electrode could not be placed on top of the storage layer in an electron-beam-addressed memory, as an optically transparent electrode would still block electrons. If a conducting electrode on top of the storage area is desirable, it will in electron-beam-read back schemes limit the area of the device that can be used for storage. In addition, the stability and cyclability of a storage device using electron-readback may be limited by the mechanical and thermal properties of the free surface of the storage medium. Only very thin protective cladding layers can be used with the electron-beam-addressing scheme, as once again these layers would prevent access by low energy electrons.

B. Problems solved by the invention.

This invention addresses the small readback signals obtained in near-field optical recording devices from very small bits. It also addresses the issues caused by the short penetration depth of low energy electrons in the devices described in patent # 5,557,596.

C. Advantages of the invention over what has been done before.

The present invention gives larger readback signals in near-field optical recording devices. Also, it can make use of storage materials that don't necessarily exhibit large changes in reflectivity between their written and unwritten states. This new invention is not as susceptible to surface conditions as the devices described in patent # 5,557,596. It also has more design flexibility and possibly better robustness than the electron-beam readback devices described in patent # 5,557,596.

D. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.)

In one embodiment, the storage medium is a diode. One layer of the diode is a material that can be changed between two or more states using a near-field optical source. We will call this the storage layer. The storage layer is in contact with another material or materials with which it forms a diode. The diode can be of any type that provides a built-in field for separating charge carriers. For example, the diode can be a pn-junction, pin-junction, or Schottky barrier depending on the material(s) used. A bit is written by locally altering the state of the storage layer with the aid of a near-field optical source. The different states of the storage material must be such that they provide a contrast in the bit detection ("read") mechanism described below. In one embodiment, the storage layer is a phase-change material similar to those currently used in optical recording. These materials can be reversibly changed from crystalline to amorphous by applying heat with the right temperature vs. time profile. The near-field optical source can be used for this purpose. The storage layer need not be a "phase-change" material, however. Any material that can be locally changed from one state to another state by means of a near-field optical source can be used. The near-field source need not operate in isolation to affect the transition from one state to another. It can also be used in conjunction with some other energy source. For example a resistive heater or applied electric field could be used to bias a large area of the storage medium while the near-field source locally affected a phase-change.

To read a bit, a near-field optical source is used to locally excite charge carriers in one of the layers of the diode. If carriers are excited in the storage layer, the number of carriers created (the "generation efficiency") will depend on the state of the storage layer in the region where photons

from the near-field source are incident. The [illegible]rs that determine the generation efficiency includ[illegible] band structure of the storage layer. Some fraction of the generated carriers of one sign (either electrons or holes) will be swept across the diode interface under the influence of the built-in field and any applied field. The current that results from carriers passing across the diode interface can be monitored to determine the state of the area on which the read photons are incident. The fraction of generated carriers that makes it across the diode interface (the "collection efficiency") is dependent upon the recombination rate in and around the area on which the read photons are incident, the effect of the bit on the built-in fields, etc. Thus, contrast in the current generated across the diode by the read photons can depend on both the local generation efficiency and the local collection efficiency. Both of these factors are influenced by the state of the region upon which the read photons are incident.

The generation and collection efficiency for carriers generated in the Layer Adjacent to the Storage Layer (LASL) can also be influenced by the presence of a bit in the neighboring storage area. Carriers can be generated in the LASL if it is the layer closest to the near-field source. Alternatively, carriers can be generated in the LASL, even if the storage layer is closest to the source, if the storage layer is sufficiently transparent to the read beam. In this case, the number of carriers generated in the LASL will depend on the number of read photons that make it through the storage layer. Thus, contrast in the read signal can be obtained by using the storage layer as a state-sensitive variable absorber. In this case, the storage layer may not itself form part of the diode structure. The transmission of this absorber can depend upon whether the beam is passing through a written or unwritten region. Alternatively, contrast in the generation rate of carriers in the LASL can arise due to differences in the electric field in the LASL due to the presence or absence of a bit in the neighboring storage layer. One way in which an electric field can influence the generation rate for free carriers is by reducing the geminate recombination rate. The collection efficiency for carriers generated in the LASL can be also be influenced by the presence or absence of a bit in the neighboring storage layer via changes in the electric field. In addition, this collection efficiency can be influenced by changes in recombination rate due to the presence or absence of a bit in the neighboring storage layer (e.g. an amorphous bit could locally increase the interface recombination velocity at the storage layer/LASL interface). Again, differences in the collection efficiency and/or generation efficiency of carriers created by the read beam provide contrast in the signal current generated across the diode.

It may be advantageous to cover the storage layer with a protective layer. During the write process, this protective layer could help to prevent chemical changes such as oxidation or thermomechanical changes such as bump or pit formation. It is possible that the LASL could serve as the protective layer as long as it is thin enough to allow writing of small bits. The protective layer may be merely a passivation layer, or it may be a conducting transparent electrode that is used to collect the photogenerated carriers.

The presence of electrodes on both the top and bottom surfaces of the storage layer and a possible LASL may offer advantages in device design. For example, uniform top and bottom electrodes will enhance the uniformity of the biasing field formed between the electrode and the storage layer. A back electrode could be present either on the side of the substrate opposite the optical sources (if a conducting substrate is used), or the back electrode could be on top of the substrate (if an electrically isolated substrate is used that provides mechanical support, but is not part of the electrical device *per se*. A top electrode could, in an optical access scheme, cover the entire top surface of the device.

It may be advantageous to cover the storage layer with a layer that enhances the thermal properties of the overall storage medium. E.g., if the storage layer is a phase-change material then it may be desirable for it to be in contact with a layer that aids in thermal quenching when trying to amorphize it. Alternatively or in conjunction with a cover layer it may be desirable to have a layer underneath the storage layer or LASL that improves thermal properties such as the ability to quench (and amorphize) the storage layer. An underlayer may also enhance the robustness of the device by preventing interdiffusion between the storage layer and the substrate material, or by discouraging delamination or dewetting of the storage layer (or LASL) from the substrate.

It may be advantageous to cover the storage layer with a layer that enhances optical properties such as an anti-reflection coating. For example, this could be used to increase the amount of light from the near field source that is absorbed in the storage layer or LASL. Alternatively, or in conjunction with a cover layer, a layer underneath the storage layer or LASL could be used to enhance the optical properties.

By monitoring the collection efficiency of a diode structure, it may be possible to control the separation of a plate containing the storage layer and diode structure from the optical sources. Alternatively, it may be possible to control this separation by monitoring the light reflected back into the near-field optical source, or by using a combination of both techniques. It may be advantageous to provide tracking and sector reference marks on the media layer surface by providing areas of contrasting reflectivity or diode collection efficiency.

When reading back signals from the media, it may be advantageous to use the near-field optical source in a constant flux mode, with the light source on steadily and the sampling window provided by translation or rotation of the media underneath the source. Alternatively, it might be preferable to pulse the optical source or otherwise modulate it in order to use a phase- and/or frequency-selective signal-to-noise enhancement technique in the diode signal amplifier electronics.

PATENT APPLICATION
ATTORNEY DOCKET NO. 10007137-1

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

ART UNIT: 2655 EXAMINER: Nabil Z. Hindi APPLICANT: Gibson et al. SERIAL NO.: 09/865,940 FILED: May 25, 2001 CONFRM. NO.: 6644 FOR: DATA STORAGE MEDIA UTILIZING DIRECTED LIGHT BEAM AND NEAR-FIELD OPTICAL SOURCES	**RESPONSE/DECLARATION** **CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8** DATE OF DEPOSIT: January 31, 2005 I hereby certify that this paper or fee (along with any paper or fee referred to as being attached or enclosed) is being deposited with the United States Postal Service with sufficient postage as first class mail on the date indicated above and is addressed to: Mail Stop Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450. **Vaughn W. North**

DECLARATION OF GARY A. GIBSON
UNDER 37 C.F.R. § 1.131

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I, Gary A. Gibson, declare as follows:

1. I am a named co-inventor in the above-captioned application and of the subject matter described and claimed therein.

2. It is my understanding that the claims in the above-recited patent application have been rejected in view of U.S. Patent No. 6,473,388 filed August 31, 2000 and issued to me, Gary A. Gibson, on October 29, 2002 (hereinafter the Gibson 388 Patent).

3. The invention as described and claimed in the above-reference patent application, Serial No. 09/865,940, filed May 25, 2001, entitled: "Data Storage Media Utilizing Directed Light Beam and Near-Field Optical Sources," ("Present Application") was conceived and reduced to practice by the inventors named therein prior to August 31, 2000.

4. Exhibit 1, attached hereto, dated March 29, 1995, is a copy of a page from my notebook. Because it is a little difficult to read, its contents are stated again here, as follows: "Near-Field Optical Version of Diode Approach – Could use near-field optical source such as used in NSOM as read/write head for any of "diode" approaches. Advantage: Penetration depth of light can be greater than that of low E electrons – fewer problems w/ surfaces (recombination, etc.) Disadvantage: Not much light out of small aperture. NSOM sources (lasers, etc.), expensive and bulky. Need to stay fairly close to medium (gap $< \approx$ bit size)."

5. The lab notebook page shown in Exhibit 1 is evidence of conception of the invention in the Present Application prior to August 31, 2000, particularly with respect to the diode embodiment shown therein.

6. Exhibit 2, attached hereto and dated August 30, 2000, contains a copy of invention disclosure that I and the other inventor in the Present Application, Alison Chaiken, prepared and submitted to our employer, Hewlett Packard.

7. The document in Exhibit 2 is evidence of conception and reduction to practice of the invention in the Present Application prior to August 31, 2000.

8. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are

punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful, false statement may jeopardize the validity of the application or any patent issuing thereon.

Declared this 21st day of December, 2004.

Gary A. Gibson

Exhibit 1 to Declaration of Gary A. Gibson

Hewlett-Packard Laboratories

PROJECT

Continued From Page

Near-Field Optical Version of Diode Approach

Could use near-field optical source such as is used in NSOM as read/write head for any of "diode" approaches.

Advantage: Penetration depth of light can be greater than that of low E electrons → fewer problems w/ surfaces (recombination, etc).

Disadvantage: Not much light out of small aperture. NSOM sources (lasers, etc.), expensive and bulky. Need to stay fairly close to medium (gap ≲ bit size).

Continued on Page

Read and Understood By

Signed: [signature] Date: 3-29-95

Signed Date

Exhibit 2 to Declaration of Gary A. Gibson

HEWLETT PACKARD **INVENTION DISCLOSURE** 9/12/00

PDNO 10007137 DATE RCVD

PAGE ONE OF 4

ATTORNEY TMD

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Descriptive Title of Invention:
Data Storage Medium Utilizing Near-Field Optical Source

Name of Project:
Atomic Resolution Storage

Product Name or Number:

Was a description of the invention published, or are you planning to publish? If so, the date(s) and publication(s):
No.

Was a product including the invention announced, offered for sale, sold, or is such activity proposed? If so, the date(s) and location(s):
No.

Was the invention disclosed to anyone outside of HP, or will such disclosure occur? If so, the date(s) and name(s):
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No.

Was this invention made under a government contract? If so, the agency and contract number:

No.

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C. Advantages of the invention over what has been done before.
D. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.)

Signature of Inventor(s): Pursuant to my (our) employment agreement, I (we) submit this disclosure on this date: [August 30, 2000].

Employee No.	Name	Signature	Telnet	Mailstop	Entity Acronym
268872	Gary Gibson	Gary Gibson	857-2125	2U-20	ISTL-ASD
498322	Alison Chaiken	Alison Chaiken	236-2231	2U-20	ISTL-ASD

(If more than four inventors, include additional information on another copy of this form and attach to this document)

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The invention was first explained to, and understood by, me (us) on this date: [APR. 14, 1995]

Full Name	Signature	Date of Signature
CHUNG CHING YANG	C C Yang	8/30/2000

Inventor & Home Address Information: *(If more than four inventors, include addl. information on a copy of this form & attach to this document)*

Inventor's Full Name: Gary Alfred Gibson

Street: 119 Seale Avenue

City: Palo Alto State: CA Zip: 94301

Do you have a Residential P.O. Address? P.O. BOX City State Zip

Greeted as *(nickname, middle name, etc.)*: Gary Citizenship: U.S.A.

Inventor's Full Name: Alison Chaiken

Street: **On file**

City State Zip

Do you have a Residential P.O. Address? P.O. BOX City State Zip

Greeted as *(nickname, middle name, etc.)*: Alison Citizenship: U.S.A.

Inventor's Full Name

Street

City State Zip

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Greeted as *(nickname, middle name, etc.)* Citizenship

Inventor's Full Name

Street

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B. Problems solved by the invention.

This invention addresses the small readback signals obtained in near-field optical recording devices from very small bits. It also addresses the issues caused by the short penetration depth of low energy electrons in the devices described in patent # 5,557,596.

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The present invention gives larger readback signals in near-field optical recording devices. Also, it can make use of storage materials that don't necessarily exhibit large changes in reflectivity between their written and unwritten states. This new invention is not as susceptible to surface conditions as the devices described in patent # 5,557,596. It also has more design flexibility and possibly better robustness than the electron-beam readback devices described in patent # 5,557,596.

D. Description of the construction and operation of the invention (include appropriate schematic, block, & timing diagrams; drawings; samples; graphs; flowcharts; computer listings; test results; etc.)

In one embodiment the storage medium is a diode. One layer of the diode is a material that can be changed between two or more states using a near-field optical source. We will call this the storage layer. The storage layer is in contact with another material or materials with which it forms a diode. The diode can be of any type that provides a built-in field for separating charge carriers. For example, the diode can be a pn-junction, pin-junction, or Schottky barrier depending on the material(s) used. A bit is written by locally altering the state of the storage layer with the aid of a near-field optical source. The different states of the storage material must be such that they provide a contrast in the bit detection ("read") mechanism described below. In one embodiment, the storage layer is a phase-change material similar to those currently used in optical recording. These materials can be reversibly changed from crystalline to amorphous by applying heat with the right temperature vs. time profile. The near-field optical source can be used for this purpose. The storage layer need not be a "phase-change" material, however. Any material that can be locally changed from one state to another state by means of a near-field optical source can be used. The near-field source need not operate in isolation to affect the transition from one state to another. It can also be used in conjunction with some other energy source. For example a resistive heater or applied electric field could be used to bias a large area of the storage medium while the near-field source locally affected a phase-change.

To read a bit, a near-field optical source is used to locally excite charge carriers in one of the layers of the diode. If carriers are excited in the storage layer, the number of carriers created (the "generation efficiency") will depend on the state of the storage layer in the region where photons

from the near-field source are incident. The [illegible]rs that determine the generation efficiency includ[illegible] band structure of the storage layer. Some fraction of the generated carriers of one sign (either electrons or holes) will be swept across the diode interface under the influence of the built-in field and any applied field. The current that results from carriers passing across the diode interface can be monitored to determine the state of the area on which the read photons are incident. The fraction of generated carriers that makes it across the diode interface (the "collection efficiency") is dependent upon the recombination rate in and around the area on which the read photons are incident, the effect of the bit on the built-in fields, etc. Thus, contrast in the current generated across the diode by the read photons can depend on both the local generation efficiency and the local collection efficiency. Both of these factors are influenced by the state of the region upon which the read photons are incident.

The generation and collection efficiency for carriers generated in the Layer Adjacent to the Storage Layer (LASL) can also be influenced by the presence of a bit in the neighboring storage area. Carriers can be generated in the LASL if it is the layer closest to the near-field source. Alternatively, carriers can be generated in the LASL, even if the storage layer is closest to the source, if the storage layer is sufficiently transparent to the read beam. In this case, the number of carriers generated in the LASL will depend on the number of read photons that make it through the storage layer. Thus, contrast in the read signal can be obtained by using the storage layer as a state-sensitive variable absorber. In this case, the storage layer may not itself form part of the diode structure. The transmission of this absorber can depend upon whether the beam is passing through a written or unwritten region. Alternatively, contrast in the generation rate of carriers in the LASL can arise due to differences in the electric field in the LASL due to the presence or absence of a bit in the neighboring storage layer. One way in which an electric field can influence the generation rate for free carriers is by reducing the geminate recombination rate. The collection efficiency for carriers generated in the LASL can be also be influenced by the presence or absence of a bit in the neighboring storage layer via changes in the electric field. In addition, this collection efficiency can be influenced by changes in recombination rate due to the presence or absence of a bit in the neighboring storage layer (e.g. an amorphous bit could locally increase the interface recombination velocity at the storage layer/LASL interface). Again, differences in the collection efficiency and/or generation efficiency of carriers created by the read beam provide contrast in the signal current generated across the diode.

It may be advantageous to cover the storage layer with a protective layer. During the write process, this protective layer could help to prevent chemical changes such as oxidation or thermomechanical changes such as bump or pit formation. It is possible that the LASL could serve as the protective layer as long as it is thin enough to allow writing of small bits. The protective layer may be merely a passivation layer, or it may be a conducting transparent electrode that is used to collect the photogenerated carriers.

The presence of electrodes on both the top and bottom surfaces of the storage layer and a possible LASL may offer advantages in device design. For example, uniform top and bottom electrodes will enhance the uniformity of the biasing field formed between the electrode and the storage layer. A back electrode could be present either on the side of the substrate opposite the optical sources (if a conducting substrate is used), or the back electrode could be on top of the substrate (if an electrically isolated substrate is used that provides mechanical support, but is not part of the electrical device *per se*. A top electrode could, in an optical access scheme, cover the entire top surface of the device.

It may be advantageous to cover the storage layer with a layer that enhances the thermal properties of the overall storage medium. E.g., if the storage layer is a phase-change material then it may be desirable for it to be in contact with a layer that aids in thermal quenching when trying to amorphize it. Alternatively or in conjunction with a cover layer it may be desirable to have a layer underneath the storage layer or LASL that improves thermal properties such as the ability to quench (and amorphize) the storage layer. An underlayer may also enhance the robustness of the device by preventing interdiffusion between the storage layer and the substrate material, or by discouraging delamination or dewetting of the storage layer (or LASL) from the substrate.

It may be advantageous to cover the storage layer with a layer that enhances optical properties such as an anti-reflection coating. For example, this could be used to increase the amount of light from the near field source that is absorbed in the storage layer or LASL. Alternatively, or in conjunction with a cover layer, a layer underneath the storage layer or LASL could be used to enhance the optical properties.

By monitoring the collection efficiency of a diode structure, it may be possible to control the separation of a plate containing the storage layer and diode structure from the optical sources. Alternatively, it may be possible to control this separation by monitoring the light reflected back into the near-field optical source, or by using a combination of both techniques. It may be advantageous to provide tracking and sector reference marks on the media layer surface by providing areas of contrasting reflectivity or diode collection efficiency.

When reading back signals from the media, it may be advantageous to use the near-field optical source in a constant flux mode, with the light source on steadily and the sampling window provided by translation or rotation of the media underneath the source. Alternatively, it might be preferable to pulse the optical source or otherwise modulate it in order to use a phase- and/or frequency-selective signal-to-noise enhancement technique in the diode signal amplifier electronics.